# BARK MAGGOTS THAT INJURE TIMBER

by

H. E. BURKE

Expert, Forest Insect Investigations, Bureau of Entomology, United States Department of Agriculture

TIMBER-INJURING BARK-MAGGOTS

## Preface

This paper is based on work done during the field seasons (April to November) of 1903, '04, '05, '06, and '07, while the writer was engaged in forest insect investigations in the Rocky Mountain and Pacific States, under the direction of Dr. A. D. Hopkins, in charge of Forest Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture.

In 1902, Mr. Edward T. Allen[1] reported that the larva

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1) Allen, Mr. Edward T., Field Assistant, Bureau of Forestry, U. S. Dept. Agric., 1902, The Western Hemlock, Bull. No. 33, Bureau of Forestry, U. S. Dept. Agric., pp. 19, 20, 23,; pl. VII, fig. 1.

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of an unknown species of Syrphid fly was causing in western hemlock timber a serious defect known as the "black check". He sent some of the larvae to Messrs. Coquillett and Schwarz, of the U. S. National Museum, who provisionally identified them as the larvae of an unknown species of the genus Xylota, family Syrphidae.

In April 1903, the writer was sent to western Washington, and ordered to determine (1) The species which is responsible for the damage; (2) The life histories and habits of the principal species and closely related forms, their natural enemies, etc.; (3) Whether or not the larvae are capable of entering healthy uninjured bark; and (4) The character and cause of previous injuries, if there are any which induce attack.

Careful investigations disclosed the fact that not only the hemlock but the firs, spruces, and pines over the whole Pacific Slopes are infested with Dipterous larvae, bark-maggots, which cause defects, black checks, to form in the timber, damaging it more or less seriously and preventing its use for the more valuable products.

Several species of the adult flies and their parasites have been reared, and a great deal of interesting and valuable information has been obtained. Part of this is published[2], and this revised, with the new information

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2) 1905, Burke, H. E., Black Check in Western Hemlock, Circular No. 61, Bureau of Entomology, U. S. Dept. Agric., pp. 1-10, figs. 1-5.

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obtained, is given herein, thus bringing the written information on the subject up to date.

The principal localities in which the work was carried on in connection with that on forest insects in general, were Hoquiam, London, Satsop, Herman (Grays Harbor City), Tulips (Humptulips), Copalis, Kent, Pialschie, Meredith, Puyallup, North Bend, South Bend, Des Moines, Ashford, Longmires Springs, Paradise Valley, Mt. Rainier, and Seattle, in the State of Washington; Cedar (Moscow) Mt., Latah Co., and Smith's Ferry, Boise Co., Idaho; Portland and Joseph, Oregon; Palo Alto, Mariposa Big Tree Grove, Wawona, Summerdale, and Yosemite, California; and Kamas, Summit Co., Utah.

So far as known, no previous record[3] of similar work

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3) Except Mr. Allen's record before noted.

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by maggots has ever been published, either in this or in foreign countries. The larvae of some species of Cecidomyidae[4] live in exuding resin, but neither form an open wound

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4) a 1871, Dec. Osten Sacken, R. Biological Notes on Diptera (art. 3rd) Trans. Amer. Ent. Soc., Vol. III, pp. 346-8, Diplosis resinicola n. sp. Descriptions and habits.

b 1880, Comstock, J. H., The Resin Inhabiting Diplosis (Diplosis resinicola O. S.) Rept. Com. Agric., 1879, pp. 256-7; pl. VI, fig. 5; Habits, Life history.

c 1890, Packard, A. S., The Pitch Inhabiting Midge, Fifth Report U. S. Ent. Com., pp.797-8; fig. 270; Notes, quotation from Comstock.

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nor cause a black check to form in the timber[5].

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5) 1903, Nov. Nickel, Lida S., The Resin-Gnat Diplosis and Three of its Parasites. Ent. News, Vol. XIV, pp. 279-84; pl. XIV, figs. 1-8. Figures, habits. Larvae do not puncture bark but live in fresh resin exuding from any small wound.

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Some Syrphidae[6] and some Psilidae[7] larvae have been

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6) See bionomic bibliography and appendix.

7) a 1898-99-00, Fletcher, James, The Carrot Rust Fly (Psila rosae Fabr.) Canada Dept. Agric., 1897, pp. 196-8; fig. 4, 1-8; Descriptions, habits, distribution, remedies; 1898, pp. 193-4 habits, remedies, distribution; 1899, p. 161, damage.

b 1902, Chittenden, F. H. The Carrot Rust Fly (Psila rosae Fab.) Bull. No. 33 n. s., Bur. Ent. U. S. Dept. Agric., pp. 26-32, fig. 6, ♂♀, a-g Descriptions, habits, distribution, remedies, literature.

c 1903, Felt, E. P., Psila rosae Fabr. (Carrot Rust Fly) 18th Report of the State Entomologist, 1902, N. Y. State Museum, pp. 99-103, fig. 1. Descriptions, habits, remedies.

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noted as living in the stems and roots of herbaceous plants, but no record of tree-inhabiting species could be found.

All notes and photographs used and not specially mentioned are original. The drawings were made under the writer's direction by Mr. Jno. F. Strauss, of the Bureau of Entomology, U. S. Dept. of Agric. The adult Diptera were identified by Mr. D. W. Coquillett, U. S. Dept. Agric., the

Scolytidae by Dr. A. D. Hopkins, U. S. Dept. Agric., Hymenoptera by Dr. Wm. H. Ashmead, U. S. Nat. Museum and the Byrrhidae by Mr. E. A. Schwarz, U. S. Dept. Agric.

# Introduction

## Bark-Maggots

Bark-maggots are the larvae or immature stage of certain species of two-winged flies (Diptera). The most important ones are rat-tailed, and belong to the genus Cheilosia, of the family Syrphidae. Others of less importance are short-tailed, leech-like in form, and belong to the same genus or other genera of the same family, while still others are elongate, wedge shaped, cornucopia-like, or terete in form, and belong to the genus Chliza, of the family Psilidae. All live in wounds in the cambium of healthy coniferous trees, and thus differ a great deal from the many species which live under the decaying bark of dead and dying trees and feed on the sap or upon the other insects found there.

The food of the bark maggots seems to be the resin that flows from the wound which they make or keep open with their strong mouth (Syrphidae) or tail (Psilidae) hooks. Splinters of bark and wood are found in the resin mass surrounding them, but they do not seem to use such material for feed.

Pupation takes place in the dying resin mass on the bark of the trunk or branch attacked. The pupae form in the last larval skin, which in the case of Syrphidae does not seem to undergo much, if any, change.

The adults are about the size of the common house-fly. They are flower lovers, and feed upon honey and pollen. They frequent sunny, moist meadowy glades in the woods, and can usually be found in such places during May and June.

## Black Check

Description.-Black check is the lumberman's name for a common defect found in the wood of the western hemlock and other western trees, and consists of a dark brown or blackish resinous scar. A few layers of the wood beneath the scar are slightly stained for a short distance around, and

all of those above are thickened, curled, or in some way abnormal. When seen in a quarter-sawn board (radial section) the defect appears as a small, thin seam (fig. 1) from one-half to one inch long, with one side (the outer) curly. In a bastard-sawn board (tangential section) it is an oval or circular spot (fig. 5, g) that varies in diameter from one-half to one inch. In both cases it lies with the grain of the wood.

Location.--The check may be found on the surface of the wood or buried deep in the heart, depending upon the size of the tree at the time it was injured and the length of time that has elapsed since the injury was made. Thus a check formed in 1890 would be covered with fifteen or sixteen layers of growth in 1907, and would probably be buried an inch or so in the wood. Checks may be found from butt to top. Therefore lumber cut from any section of the tree may be injured.

## Economic Importance

Timber badly affected with black check is nearly worthless for finishing, turning, staves, woodenware, and paper pulp, for which it would otherwise be excellent. The injury is very conspicuous in bastard-sawn lumber, unfitting it for finishing or turning, while in that quarter-sawn (fig. 1) or cut across the grain it is apt to form an open seam which renders it worthless for staves and woodenware, where tightness is required. It is quite a serious defect in timber used for pulp, because of the trouble in bleaching out the dark spots in the product. It does not seem materially detrimental to timber for rough boxes, construction and other heavy work, so much loss may be saved by using checked timber for these purposes.

Hemlock timber and fir timber, especially that growing on the lowlands, is often seriously affected. Nearly every board examined in a large quantity of stock cut from lowland hemlock timber at Hoquiam, Washington, 1904, contained numerous examples of the defect.

Taking into consideration the common occurrence and

## Preliminary Wounds

The most important makers of the preliminary wounds are barkbeetles of the family Scolytidae (Hylesinus, Scolytus, Dendroctonus). These beetles, expecially species belonging to the genus Hylesinus, often make a short mine through the outer bark of healthy trees. This mine, though probably usually made for food purposes, may somtimes be made in an attempt to kill the tree. In either case, it is soon abandoned and the slight flow of resin which exudes from it offers the proper conditions for the development of the bark maggot. The adult fly is usually quick to take advantage of this be depositing its eggs.

Next to the barkbeetles in importance come the sapsuckers (Sphyrapicus). These birds make many small wounds in the bark of healthy trees to get the sap which flows there. After the sap stops flowing, the birds leave and resin exudes from the wounds. The fly takes advantage of this, as before.

Some Lepidopterous (Parharmonia, Sesia) larvae form wounds in the bark which cause the resin to exude in proper condition for the maggots, and so do many mechanical injuries, such as bruises, scrapes, cuts, and punctures of various kinds. In every case, from whatever cause, where the conditions are proper, the fly may deposit its eggs.

## Indications of Maggots Work

The bark-maggot's present and past work is usually clearly indicated to the trained observer. When the larva is present and for a year or so after it leaves the wound, there is a small globular reddish or grayish mass of resin on the outer bark at the entrance to the wound. This mass is .6 of an inch to one inch in diameter, and .4 to .6 inch in depth. It is composed of resin, and the reddish excrement of the maggot. It finally dries up and becomes covered with a black fungus growth. This remains on the bark as a black spot for many years, and indicates the work (black check) in the wood beneath.

Broken limbs, barkbeetles, bark-borers, sapsuckers, or anything that makes a wound in the cambium which causes a small flow of resin, causes similar spots to form on the bark, and these may easily be mistaken by the untrained for indications of the bark-maggot. There are some slight differences in size and shape, however, and the eye trained by a little practical experience is seldom mistaken. The regular, circular spots about an inch in diameter nearly always indicate the work of the bark-maggot.

## Distribution

So far as the collections of the office of forest insect investigations show, bark-maggots and the resultant black check are distributed over all the forest areas of the Pacific Slope. These areas include the western division of the Rocky Mountain forests and all of the Pacific Coast forests. Specimens have been collected from Washington, Oregon, California, Idaho, and Utah.

Closely related adults of the genus Cheilosia are found over all of North America and Europe. Associated with them are trees closely related to the trees attacked on the Pacific Slope. It seems to the writer, therefore, that work must be widely distributed over the northern hemisphere, and has not hitherto been recorded because it has not been studied.

Altitude seems to have no effect on the distribution. Specimens seem as common at 8,000 feet as they are at 20 feet. Mr. Allen mentions altitude as a probable reason for the immunity of certain hemlock belts from attack, but the writer's observations completely refute this suggestion. Other belts at higher altitudes were found badly infested.

Conifers seem to be the only trees attacked. Of these the firs and hemlocks are the worst infested and most seriously injured, but pines and spruces are also attacked and damaged to some extent.

## Natural Enemies

The bark-maggot living in the mass of resin, as it does, and surrounded by bark, is well protected from natural enemies. Predaceous insects do not seem to get at it, and no fungus or bacterial diseases were noticed. Hymenopterous parasites, however, are able to reach it, and two species of these, one an ichneumonid (Syrphoctonus maculifrons Cr.) and the other a chalcidid (Eutelus flavipes Walk.) attack some species of the maggot and destroy a number of them every year. Whether the injurious insect can be controlled by using these parasites is yet to be determined.

## Historical Notes

The hemlock bark-maggot and its work was discovered first by Mr. Allen in western Washington in 1900. He reported the discovery to the Department of Agriculture, but could not make a special study of the trouble, so did not succeed in obtaining the adult nor the important points in the life history.

The writer's investigations commenced at Kent, Washington, April 7, 1903, and ended at Pacific Grove, California, October 18, 1907. Between these two dates the following localities were visited and the conditions studied: Kent, Miller's Landing, Cosmopolis, Aberdeen, Hoquiam, London, Montesano, Elma, McCormick (Rock Creek), South Bend, Nalicotta, Heerman (Grays Harbor City), Puyallup, Satsop, Westport, Tulips (Humptulips), Copalis, Moclips, Tacoma, North Bend, Snoqualmie Falls, Snoqualmie, Pialschie, Des Moines, Zenith, Seattle, Ashford, Longmires Springs, Paradise Valley, Mt. Rainier, and Meredith, Washington State; Portland, Wallowa, and Joseph, Oregon; Cedar (Moscow) Mt., Latah Co., and Smith's Ferry, Boise Co., Idaho; Palo Alto, Big Basin, San Mateo Co., Wawona, Mariposa Big Tree Grove, Summerdale, Yosemite, Little Yosemite, Lake Tenaya, Tioga Road, Soda Springs, and Pacific Grove, California; Deadwood, Lead, Elmore, Spearfish, Spearfish Falls, and Nemo, South Dakota; St. Louis, Missouri; Woodville, Virginia; and Kamas, Park City, Panguitch, and Panguitch Lake, Utah.

He first found the hemlock maggot at work at Hoquiam, Washington, on August 11, 1903. The fir maggot was discovered in the lowland fir (Abies grandis Lindl.) at Satsop, Washington, on July 8, 1903; in the Alpine fir (Abies lasiocarpa Nutt.) at Smith's Ferry, Boise Co., Idaho, on October 24, 1904; and in the white fir (Abies concolor Parry) at the Mariposa Big Tree Grove, California, on June 1, 1906. The spruce maggot was found first in the Sitka spruce (Picea sitchensis T.M.) at Hoquiam, Washington, on June 8, 1903; and the pine maggot in the yellow pine (Pinus ponderosa Laws) at Cedar (Moscow) Mt., Idaho, on September 29, 1903, and in the lodgepole pine (Pinus murrayana Oreg.Com.) at Smith's Ferry, Boise Co., Ihado, on October 26, 1904. The spruce bark-maggot field investigations ended in 1904, the hemlock bark-maggot and the pine bark-maggot field investigations in 1906, but the fir bark-maggot field investigations were kept up through 1907.

## Methods of Preventing Losses

Black check is the result of the work of the bark maggots during past years, or even centuries, and is thus distributed all through the wood of the trunks of the matured affected trees.

Practical methods of preventing losses must therefore be those that utilize the injured timber to the best advantage, rather than those that attempt to prevent the injury itself.

If stock is to be used for turning, woodenware, finishing, and paper pulp where clear stuff is required, timber should be selected which, as is revealed by the absence of the old resin masses or indicating spots on the bark, is free from the trouble.

Timber that is badly infected by the check should be used for box material or construction purposes where it is as good as clear stuff, or certain special lots may, if properly sawn and polished so as to give the bird's-eye or curled wood effect, be used to good advantage for natural-wood finish.

In the future, if trees susceptible to the check are planted for commercial purposes, remedial measures should be simple. As the maggot work is plainly indicated by the resin masses on the bark and the insect spends so much of its life in the maggot stage, it should be an easy matter to go through the plantation and destroy the pest by crushing or by painting the wound with crude petroleum or some similar substance. This method, if thoroughly carried out, would soon exterminate the insect. It could be done while pruning or cultivating, and should be inexpensive and efficient.

# THE HEMLOCK BARK-MAGGOT

## (Cheilosia alaskensis Hunter)

The hemlock bark-maggot is the most important economic species of the bark-maggots. So far as known, it causes the most damage, or rather, damage to the most important tree, economically considered. For this reason, and because its injuriousness to the western hemlock was the cause of the investigations being made, it is treated first and more fully than the other species.

## HISTORICAL

### First Record

The hemlock bark-maggot and its work, the black check, were reported first in 1900 by Mr. Edward T. Allen, of the Bureau of Forestry. He collected some of the maggots and sent them to the National Museum, where they were provisionally identified by Messrs. Coquillett and Schwarz as the larvae of an unknown species of the genus Xylota, family Syrphidae. Mr. Allen described the check and published his observation that the larva probably caused the same, in his bulletin, The Western Hemlock, in 1902. (Allen, 1902)

### Investigations by the Writer

In 1903, 4, 5, and 6, the writer, under instructions from Dr. A. D. Hopkins, made special investigations of the trouble at Kent, Miller's Landing, Cosmopolis, Aberdeen, Hoquiam, London, Elma, McCormick, South Bend, Nahcotta, Heerman, Puyallup, Satsop, Montesano, Westport, Tulips, Copalis, Moclips, Tacoma, North Bend, Snoqualmie, Snoqualmie Falls, Fialschie, Des Moines, Zenith, Seattle, Ashford, Longmires Springs, Paradise Valley, Mt. Rainier, and Meredith, Washington State, and Portland, Oregon. The object was to determine: (1) The species responsible for the damage; (2) The life histories and habits of the principal

species and closely related forms, their natural enemies, etc.; (3) Whether or not the larvae are capable of entering healthy uninjured bark; and (4) the character and causes of previous injuries which induce attack.

In 1903. The first examination of infested trees was made at Hoquiam on August 11, 1903. Maggots of various sizes were found to be quite common in the bark of the trunks of living trees. Their presence was indicated by small masses of resin on the surgace of the bark. In and beneath each of these a single maggot was at work in a cavity or hole which extended to the surface of the wood, where there was a wound, evidently caused by this insect. Similar wounds, partially healed, and others several years old were found in the same trees, from near the outer layers of the sapwood to layers deeply buried in the heartwood. The latter were readily recognized as the black check defect and there was no doubt left as to their being caused by the maggot.

Experiments with different methods of rearing the adult insect were at once started. At first the infested resin masses with a portion of the adjoining wood were cut out and placed in jars and tin boxes[1], but they soon dried up or moulded. Then cages of netting placed over the resin masses on the trees were tried. These proved too flimsy, and were hard to examine. Finally, cages were made from small baking-powder and spice cans, by knocking off the bottoms, cutting the sides into narrow strips, and punching holes for tacks in the tips of the strips, (fig. ). These were found to be admirably adopted to the work; they were durable, could be readily fitted to any surface, and were easily examined by simply removing the lid.

The investigations were started too late in the season to secure the pupae or adults, but many larvae in various stages of development were collected and studied, and a number of the infested wounds were covered with the tin cages.

One of the most important results of the first sea-

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[1] If pupae are collected this way, the adults are easily reared.

son's work was the discovery that the principal primary cause of the attack and subsequent injury by the bark maggot was the work of the hemlock barkbeetle (Hylesinus n.sp.). This was found excavating short burrows in the healthy bark, and through it to the surface of the wood, where a small wound was made, causing a slight flow of resin. These resin-filled burrows which were soon abandoned by the beetles formed ideal places for the young bark maggots to begin their work, and were, apparently, utilized in preference to any other wounds.

In 1904: The investigations of 1904 gave prompt results. Upon the first examination of the breeding cages on April 27 one adult male was found. On April 30 a female emerged, and May 8 two males were secured from resin masses placed in cages in the laboratory. Another female was taken on May 10, while it was flying in the sun in a field near the forest. No adults were found in the cages or collected in the field after May 10, which would indicate that in the locality of Hoquiam the adults emerge during the last of April and the first of May. Specimens of the fly were sent to Mr. D. W. Coquillet, who identified them as Cheilosia alaskensis Hunter. The last examination of the field rearing cages was made on October 10. A number of resin masses that were caged in October, 1903, still contained larvae. This would indicate that the insect lives several years in the larval state. The fact that larvae of various sizes were found at all times of the year and adults only in the spring strengthens this belief.

Besides the adult fly, two hymenopterous parasites (Syrphoctonus maculifrons Cr. and Eutelus flavipes Walk.) were reared in 1904 from the caged resin masses, and two small byrrhid beetles (Amphicyrta simplicipes Mann. and Simplocaria nitida Mots.) were found on or near them. The parasites emerged in June.

During the winter of 1904, a report on the results of the work of the seasons of 1903-04 was written. This was published May 24, 1905, as Circular No. 61, of the Bureau of Entomology (Black Check in Western Hemlock.) Burke, 1905)

In 1905. On May 12, the date of the first examination in 1905, one dead female Cheilosia was found in a cage which had been placed over a fully developed resin mass on May 19,

1904. A number of resin masses were examined and many adults seemed to have emerged. A number of large larvae were pupating in the outer masses. Many of these pupae contained Rutelus larvae. On May 23rd a number of Cheilosia larvae showed where the wood had been eaten during one year's growth, while those of the larger ones showed where it had been eaten for several years. Several larvae were found at the edges of old axe and split wounds, but most of them were in the old barkbeetle entrances. On June 19 a dead male was obtained from a cage and a number of Rutelus larvae were found in the empty Cheilosia puparia.

At Pialschie, on June 28, many larvae were found in the healing punctures made in the bark of a large tree by the sapsuckers. One larva was very small and appeared to be of the season's growth. It was working on the first or healing layer of wood that was growing over the sapsucker wound.

On September 2, between Paradise Valley and Longmire's Springs, at a elevation of from 3000 to 4000 feet, a number of medium to large sized larvae were found in resin masses on the bark of trees in the middle of the forest.

At Pialschie on September 6, a larva was found to have entered an old resin mass that was healing over. Fresh barkbeetle galleries than ran just through the bark were common.

In 1906. The only observations of 1906 was made at Pialschie on April 13, a number of resin masses were examined and many medium sized larvae were found. Some empty masses looked as though the adults had just emerged. These had the inner wound filled with a watery waxy pitch and had not begun to heal.

## DISTRIBUTION

Black Check, the maggot work, was found to be common at every point in the hemlock belt visited by the writer. Trees at Hoquiam, Satsop, Copalis, Kent, Puyallup, Pialschie, Des Moines, Paradise Valley, South Bend, North Bend, and Seattle, in Washington, and Portland, in Oregon, all

showed the characteristic work. Mr. Allen says in his bulletin (Allen, 1902) that the only hemlock forest region found wholly free from the defect was a belt along the west slope of the Cascade Mountains above an elevation of 1800 feet. Similar regions of high altitudes may also be found to be immune. So far as the writer could determine, however, altitude does not affect the distribution. Maggots were common in the bark of trees between Longmire's Springs and Paradise Valley at altitudes of from 2000 to 4000 feet. Adults have been collected at Cook's Inlet, Alaska (Hunter, 1897); Yakutat, Alaska, (Coquillatt, 1900); and Port Renfrew, Glacier, and Vancouver, British Columbia, (Osburn, 1908).

It seems very probable that the maggot has the same range as the hemlock, which extends over portions of Alaska, British Columbia, Montana, Idaho, Washington, Oregon, and California.

## FOOD PLANT

So far as known, the only food plant of the hemlock bark maggot is the western hemlock (Tsuga heterophylla (Raf.) Sargent.). During a period of investigations that extended for five years, this was the only tree found to be attacked by this insect. All of the adult flies recorded in collections come from localities in the hemlock belt, so it is very probable that the hemlock is the only feed plant.

## DESCRIPTION

### The Injury

Primary Wound (Fig. ) A careful study proved quite conclusively that the maggot does not enter perfectly healthy uninjured bark. And there is no need for it to do this, for in almost every tree there are numerous small wounds by which it may enter. It probably enters any wound from which there is a slight exudation of resin, but in the great majo-

rity of cases it enters through the abandoned burrow (gallery) of the hemlock barkbeetle (Hylesinus n.sp.) These burrows are quite common in the bark of most of the trees. The beetles[1] excavate them through the healthy bark to the

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[1] The burrows that were found occupied by the beetle or in the process of excavation usually contained but a single adult, which was nearly always a female. Only four males were found among twenty-nine specimens examined. In two instances a male and female were found together in the same burrow.

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surface of the wood forming a small circular wound from which the resin exudes. They do this all through the season from April to November, evidently for the purpose of obtaining food or for hibernation, and not for the purpose of depositing eggs, since neither eggs nor larvae of the beetle were found in them, and they were soon abandoned. Some of them were healed over without further injury to the wood, while others were open and contained a small amount of resin. The abandoned burrows, with the resin exuding, formed ideal places for the young bark maggots to begin their work, and were, apparently, utilized in preference to any other wounds.

Sapsuckers in their quest for sap often form rows of similar, but larger, wounds. These are ideal when partially healed, and a number of maggots were found in them. Some maggots were also obtained from the edges of old windchecks, scrapes, and axe wounds.

The primary wound, therefore, is a small resin-filled hole about 0.08 inch in diameter, which extends through the healthy bark to the surface of the wood.

Maggot Wound (Fig. ) The maggot enters the primary wound and feeds on the inner bark and outer wood, thus leaving the entrance as the barkbeetle or other maker left it. The tail extends out through the entrance to the air, while the head and body lie in the inner part next to the wood. As the maggot feeds it makes a circular, oval, or irregular excavation in the outer wood. This is small the first year, but is enlarged in the newly forming layers of

wood as the maggot grows year after year. Most of the wounds examined showed three of these annual excavations, but some showed as high as five. This inner wound, therefore, is a succession of irregular pits, which are smallest in the inner layers of the wood affected. It is from one-half inch to one inch in diameter. A few layers of wood beneath the wound are stained brown for some distance around by the resin which fills both the inner wound and entrance and forms quite a mass, 0.6 inch to one inch in diameter, and 0.4 to 0.6 inch in depth on the outer bark. This mass is usually irregular and globular in form and reddish-gray in color. When finished it contains the pupal cavity or chamber.

The finished maggot wound is thus composed of three parts: The inner wound or chamber beneath the outer bark where the maggot usually keeps its head and body and does its feeding; the old primary wound through the outer bark which forms an entrance to the inner wound and through which the maggot's tail extends through the resin to the air; and the resin mass on the outer bark which contains the pupal chamber. The inner wound is from one-half to one inch in diameter, the entrance about 0.08 inch and the resin mass 0.6 inch to one inch.

The Black Check (Fig. ) As soon as the maggot leaves the inner chamber, the irritation ceases and the wound begins to heal. The cambium grows down into it year after year, and the annual growth of wood formed there and the annual growth of wood slowly covers it over until in three or four years it is completely buried beneath the new growth and thus forms the black check.

As the wood grows down into the wound in healing it over, a depression is formed in each new layer, but sometimes the new layer thickens around the depression and forms an elevation above the surrounding surface. In both cases an ornamental curl is formed that will show as a bird's eye effect in bastard or longitudinal sections of the wood.

The completed check is a dark brown or blackish resinous scar underlaid with a few layers of slightly stained wood and covered with thickened, curled, or in some way abnormal ones. When seen in a quarter-sawn board (radial

section) it appears as a small, thin seam from one-half to one inch long, with one side curly. In a bastard-sawn board )tangential section) it is an oval or circular spot that varies in diameter from one-half to one inch. In both cases it lies with the grain of the wood.

Any wound in the bark and sapwood which heals over will cause a check or "gum spot" in the timber. Barkbeetles, bark-borers, woodpeckers, falling limbs, and various other things make such wounds, so many similar checks resulting from different causes are often found in the same tree. In the hemlock, however, the characteristic black check is made only by the bark maggot.

## The Insect

The Egg The egg was not observed.

The Larva or Maggot (Fig. ) The larva is a white maggot with a small, poorly defined head; a subfusiform (slightly tapering) subcylindrical, ten-segmented body; and a long, two-jointed, protractile, telescopic tail. In a full-grown specimen, the body is about 10 mm. long, by 3 mm. in diameter, while the tail is usually as long as the body and about 5 mm. in diameter. The entire surface seems smooth to the naked eye, but it is quite thickly covered with minute spines which are arranged in definite groups. The largest and strongest of these are on the dorsal surfaces of the thoracic segments.

The head is small, retractile and usually almost buried in the body. The dorsal part is composed of a pair of conoidal antennal lobes, each of which bears two small conoidal distal branches. The inner one of these bears a small protractile second joint. Ventrad of these is a fleshy fold which is covered with stout spines. It forms the upper lip or front the head. Ventrad of it is the mouth, which seems to be a mere fleshy entrance, without distinct parts. Projecting from it are a pair of strong forked dark, chitinous hooks. The inner dorsal fork of these is much larger and stronger than the other.

The first thoracic segment is a heavily ridged bristly hood which almost completely covers the head. It bears on each of the dorso-lateral posterior surface a dark, subconical, hornlike projection which terminates in a spiracle. These spiracles may be drawn in and covered by the second thoracic segment. The second and third thoracic segments are regular and without projections.

The first abdominal segment bears on its dorsal surface a pair of not very widely separated, fleshy, conical, elevations. These appear to be the rudiments of the pupal spiracle bearers. On the posterior ventral surface of the first abdominal is a roll which bears two slightly elevated cone-like projections. These have some large spines at their tips and probably serve as feet. The second abdominal is similar to the first, but is without the dorsal elevations and has larger feet. The third has the feet larger, more cone-like and separated at their bases, while the fourth, fifth, sixth, seventh, and eighth have still larger feet more widely separated. The seventh has the large vent at its posterior ventral margin and the eighth is smaller than the preceding segments, and forms the base to the tail which includes the ninth. The tail bears near its middle a large pair of lateral tubercles or feet which project dorsally, about three-fourths of the distance posteriorly a small pair of lateral conical feet, and about five-sixths of the distance posteriorly an enlargement, with two large lateral feet which project ventrally. It terminates in a dark, strongly chitinized bifurcate piece, each fork of which bears on the outer surface near the tip four strong plumose bristles and terminates in a spiracle which opens on the posterior surface or tip. Sometimes a number (1-10) of convoluted, cylindrical organs protrude from the vent. These appear to be the rectal glands.

The Puparium (Fig. ) The last larval skin forms the puparium. It is almost unchanged except in the dorsal surface of the thorax and first abdominal segment. This surface has been pushed forward by the protrusion of the pupal horns and forms a distinct anterior surface which has a depressed central area and a strongly developed bristly ridged lateral and posterior margin. Projecting from the dorsal part of this and not very widely separated are the pupal horns or spiracle bearers, each of which terminates in a spiracle. Part of the dorsal skin of the first abdom-

inal segment has been pushed up to form large conical bases about these horns. The tail is thin and appears empty except for the old tracheal tubes. The vent is marked by a dark chitinous appearing oval margin and dark irregular plates which seem to be divided into two groups. The puparium is quite thin and transparent and the inclosed pupa can be clearly seen.

The Pupa (Fig. ) The pupa is composed of an outer transparent skin and an inner mass which is developing into an adult. In the earlier stages, the inner mass is creamy white and without visable parts, but in the later stages the parts become more and more distinct and finally the developing adult can be clearly seen.

The skin is quite smooth all over. The anterior dorsal surface is extended into two horns or spiracle-bearing projections. These are nearly cylindrical at the tips and have large conical contiguous bases. The tips and the skin of the anterior and anterior ventral surfaces is smoky. Across the front and extending ventrally along the sides for a short distance is a transparent horizontal band which separates the smoky area into two parts. In the center of this band is a dark raised tubercle. Running ventrally from this is a slightly darkened stripe. In the later stages the large dark red eyes, the antennae folded on the front of the head, the grayish wing pads on the sides, and the mouth parts and legs on the ventral surface, may be clearly seen through the skin.

The Adult or Fly (Fig. ) The adult is a blackish or blue-black fly, about the size of the common house fly. It is 9 mm. in length and 3 mm. in width, with wings 8 - 9 mm. long. The head, body and legs are rather densely covered by medium black or grayish hairs. The wings are transparent and without spots. The male is more slender than the female, which has a rather broad pointed abdomen and the hairy covering is longer, darker and more abundant. The third or large joint of the male antennae is distinctly smaller and darker than the female one and the frontal tubercles and antennal bases are less pronounced. The male eyes touch for quite a distance on top of the head, but those of the female are quite widely separated.

## SEASONAL HISTORY

### Hibernation

The hemlock bark-maggot passes the winter as a larva in the resin mass or in the bark of the host tree. The first winter it is a small larva, and the second a full-grown one. The evidences tend to show that both stages of the larvae withdraw to the outer mass to hibernate, but the writer is inclined to believe that in mild climates the small larvae feed in the inner wounds all winter. The large larvae probably rest up and prepare for pupation.

On October 9, 1904, and November 19, 1903, both small and large larvae were com on in the outer masses. This was also the case on April 29, 1904, and May 12, 1905, so hibernation probably commences in October and lasts until the middle of May, but, because of varied climate, there is much variation.

### Activity of Overwintered Large Larvae

The overwintered large larvae do not seem to do any feeding in the spring, but at once get into position for pupation. They were found curled up in the outer resin masses from the earliest observations in April until May 23, 1905.

### Pupation

Pupation seems to take place only in the spring, but the hibernating large larvae are probably preparing for it all winter. It takes place in the outer resin mass and the larvae were found in the characteristic pupal position as early as October 9, 1904, and as late as May 23, 1905. Pupae were found on April 27, 1904, and May 27, 1905 so

there is also much variation in the time of pupation. As nearly as could be determined the stage is moderately short, from six to twelve days.

## Emergence of Adults

The adults emerge from the 1st of April to the middle of June. On April 13, 1906, fresh emergence holes were found; April 27, 1904, one live male was found in a rearing cage; April 30, 1904, one female was reared; May 8, 1905, two males emerged; May 12, 1905, one female, and June 19, 1905, one male was found dead in a cage in which a pupa was placed on May 27, 1905; a female was taken in the field on May 10, 1904, and one on May 18, 1905. The adult stage is moderately short, probably a month or two.

## Oviposition

Oviposition was not observed but as the adults are only found in April, May, June, it must take place during these months, probably in the latter part of May and during June. On May 6, 1904, what was taken to be an egg of this species was found, but it could not be determined, and is questionable. Quite small larvae were found from June 28th to September 8th. These would indicate oviposition in the spring or early summer.

## Activity of Small Larvae

The small larvae start to feed as soon as they hatch, May or June, and continue to feed until they hibernate in the fall, October or November. Active feeding ones were obtained on June 28, 1905, July 26, 1905, August 12-24-26, 1903, August 24, 1904, September 8, 1904 and October 13, 1903.

## Activity of Overwintered Small Larvae

The overwintered small larvae commence feeding in the early spring, April and continue to feed until they hibernate in the fall, October or November. They were found feeding in the inner resin mass on April 13 and throughout April, May, June, July, August, September, and October, until November 19th.

## Length of Life Cycle

The life cycle of the hemlock bark-maggot is complex, but the typical period for the development of the adult from the egg appears to the writer to be two years. Thus from eggs laid in the spring of 1903, adults would emerge in the spring of 1905. In the fall and spring two sizes of hibernating larvae are always found. One seems full-grown and the other is small. Large, well developed masses containing larvae at least a year old caged in August, 1903, still contained healthy large larvae on May 16, 1904; another large mass caged May 19, 1904, yielded an adult May 12, 1905. Then too, the work in the wood shows that two or more annual layers are eaten by the larvae. These observations show clearly that the life cycle is at least two years. Often times it seems that it must be more. As high as five successive layers of new growth may be eaten. Larvae that appeared large and full-grown on August 24, 1903, appeared to be in the same condition May 16, 1904. It is therefore probable that while the insect usually takes about two years to develop into an adult from the egg, it may take four or five years if the conditions are unfavorable.

## Habits

Larva. As soon as it hatches from the egg the young larva commences to feed upon the surrounding soft inner bark and outer wood (cambium) tissues. These it tears

and bruises with its strong mouth hooks until quite a wound is made. The sap is probably all that is used for food for the resin and the fibrous parts of the bark and wood are pushed out of the wound to form the resin mass on the bark. As it feeds it enlarges the wound which in the course of two or more years grows in size from 1/10 inch to one inch or more in diameter. Feeding probably stops during the first winter while the larva is hibernating in the outer resin mass and most certainly does during the second or last winter when the larva is getting ready for pupation.

During its active stage the larva is usually found with its head and body beneath the bark in the inner wound and its long rat tail extending out through the entrance and resin to the surface of the mass upon which the spiracles float. (Fig. ) It moves its body at will in and out of the entrance and through the resin mass and even on the surface of the mass, but always has the spiracle-bearing extremity of the tail upon the outer surface.

Most of the breathing must necessarily be done through the tail spiracles but the pair on the anterior portion of the body seem to be functional and may be used to some extent.

In hibernating the larva withdraws to the outer mass and seems to lie quiescent, breathing through its tail as before. It probably hibernates more because of the unfavorable food condition than it does because of the direct influence of the climate upon itself.

In pupating, the dorsal surface of the thorax and first abdominal segments of the last larval skin are rather flattened and pushed up and forward so that they lie in the surface of the resin mass, while the horn-like pupal spiracle-bearers are pushed through the dorsum of the first abdominal and project from the mass. The tail withers up some and becomes functionless and the pupa breathes through its horns. The skin does not seem to thicken and the outward change is so slight that the puparium closely resembles the larva. But it may always be distinguished by the projecting pupal horns.

Adult. The adult emerges from the pupal skin and puparium by pushing off the anterior end. The wings soon

expand and it flies away to mate. It is very quiet in habits and is rarely found. Of the two specimens taken in the field, one was flying in the sun in a little meadow at the edge of a forest and the other was resting on the bark of a tree at the edge of a sunny glade in the thick forest

Oviposition was not observed, but there is every indication that it takes place on the exuding resin which flows from any slight wound.

## ECONOMIC FEATURES

Injurious Character of Work. The hemlock bark-maggot is important economically because it causes an injurious defect known as the black check to form in the wood of the western hemlock. This defect is quite common and prevents a great deal of otherwise fine timber from being used for the more valuable products. Timber badly affected with the check is nearly worthless for finishing, turning, staves, woodenware and paper pulp, for which it would otherwise be excellent. In a large quantity of stock cut from lowland timber at Hoquiam, Washington, in May, 1904, nearly every board examined by the writer contained numerous examples of the defect. As is intimated by Mr. Allen (Allen, 1902, p. 23), the damage is widespread and serious. He says (Allen, 1902, p. 20) "It is useless for manufacturers of cooper stock or finishing lumber to buy infested logs. (Allen, 1902, p. 23) The checks lie with the grain and become very conspicuous if the log is bastard sawn. In boards cut across the grain they are less conspicuous, but kiln-drying is apt to open them clear through the board and to render the latter useless where tightness is required. This is one of the chief reasons to object to the use of hemlock for woodenware, for which it otherwise is excellent." Taking into consideration the common occurrences and injurious effect of the blemish in the lumber for certain purposes and the large amount of timber concerned, the total loss caused by the check must be considerable.

Beneficial Character of Work. While on the whole, the

check is quite injurious it may also cause some benefit. Each check causes curls to be formed in the layers of the wood covering it. These curls form bird's-eyes in the lumber and when quite common, should cause very pretty effects in finishing stock, ornamental stock, indian clubs, etc. If the proper advantage was taken of this, much loss might be turned into profit.

Evidences of Attack. A present or past attack by the bark maggot is clearly indicated on the outer bark of the tree attacked. In the first case there will be an irregular, globular, reddish-gray mass of fresh resin which covers the maggot and its open wound. In the second case there will be a dry mass of resin covered with a black fungus growth. This indicates where a fresh wound once was. Beneath it will be found curls in the wood and beneath them, buried at various depths in the wood, will be found the black check.

The blackish fungus-covered dry resin mass indicates the blemish in the wood, while the fresh resin indicates that the injury is taking place or is healing over.

Favorable and Unfavorable Conditions for Attack. The susceptibility to attack varies a great deal with the different individual trees. Thin smooth-barked trees are the worst infested, while those with a thick, rough bark are the least. For this reason, the larger trees are better protected than the smaller ones. A tree may therefore be badly infested in its youth when the bark is thin, and free from attack when it becomes more mature and the bark rougher. Small trees growing on the shady hillsides near swamps usually have the smoothest bark and are nearly always the worst infested. Vigorous trees seem to be more susceptible than weak ones, probably because they offer the better nutriment and more favorable conditions for the development of the insect.

It is probable that one reason the thin smooth barked trees are more susceptible to attack is because they are more apt to be injured by the barkbeetles, sapsuckers, etc., which injuries must take place before the maggot can effect an entrance into the cambium. In a like manner, the vigorous trees may be so susceptible because they offer better nutriment to the primary injurers. Vigorous

trees whose bark contains small wounds from which the resin is exuding offer the most favorable conditions for attack, while large, old, rough-barked trees without any wounds in the bark offer the least favorable.

## Methods of Preventing Losses

In Mature Timber. Since the black check is the result of the work of the maggots during past years, or even centuries, and is thus distributed all through the wood of the trunks of the mature affected trees the only method of preventing losses in these trees are those which utilize the injured timber to the best advantage. That from badly affected trees can be used for box and construction material or other purposes where the checks are not objectionable. The bird's-eye or curled wood can be used for natural wood finish. Where clear stuff is required, as in finishing, turning, woodenware, etc., timber should be selected which, as indicated by the absence of the old black resin masses on the bark, is free from the trouble. Manufacturers who desire clear stuff should use special care in buying logs from certain localities, especially the low lands, where the trees are apt to be badly affected. As the check in the wood is plainly indicated by the black spot on the bark, a keen observer can readily tell the amount of damage inflicted on any particular tree, except possibly in the case of large trees which were badly infested in their youth and then became free from attack when they grew older. In such trees the timber would contain checks near the heart and be clear in the outer parts, while the old resin spots might indicate checks throughout. Careful observation, however, should enable the observer to tell the age of the check by the old or fresh appearance of the indicating resin mass, and he would have little trouble in estimating his timber.

In Young Growth. Bark maggot injury to young growth should be easily controlled either by direct or indirect methods, or a combination of both.

The direct method would be to kill the maggot in its wound in the bark. The wound is quite conspicuous and

easily located. If it was covered with crude petroleum or some similar substance the maggot could not breathe and would die. This method is simple and if thoroughly carried out would soon prevent the insect from being injurious. It could be done while pruning, thinning, or cultivating, and should be inexpensive. It would probably be the most effective method to use in commercial plantations.

The indirect method would be to destroy the bark-beetles, sapsuckers, etc., which cause the primary injuries to the bark that enables the bark-maggot to obtain an entrance. If there were no primary injuries the maggot would probably soon disappear. The barkbeetles cause the large majority of primary injuries, and if they were controlled very little trouble would occur. They rear broods in felled and dying young or mature trees. These should be carefully cleaned up and the broods destroyed by barking or burning during the winter season. The sap-suckers could be watched and if found to be injurious could be shot. This method of preventing the primary injury by destroying the makers and thus controlling the maggot would probably be most effective in the natural forests of young growth.

Both methods could easily be used at the same time.

## NATURAL ENEMIES

The bark-maggot seems rather free from natural enemies. There was evidence of any bacterial or fungous disease, and it is so concealed in the bark and resin that it is well protected from predatory insects and other animals. Two hymenopterous parasites were reared from the puparia, however, and as both species are fairly common, they probably aid greatly in keeping the trouble in check. Dr. Wm. H. Ashmead, of the U. S. National Museum, identified one of these as an ichneumonid (Syrphoctonus maculifrons Cr.) and the other as a chalcidid (Eutelus flavipes Walk.).

## Syrphoctonus maculifrons Cr.

This is a small, wasp-like, ichneumon fly about 0.36 inch in length. It has a dark body marked by a few white patches at the bases of the wings and legs. The face is nearly covered by a square of white, and the legs are reddish-brown. The abdomen of the male is more slender than that of the female, and the white square on the face is larger. The earlier stages are not known. Pupation takes place in the body of the host in the outer resin mass. The adult emerges during the latter part of June or the first of July. A mass caged August 26, 1903, yielded a male June 16, 1904. One female emerged June 27, 1904, and one July 1, 1904. Each maggot furnishes subsistence for but a single parasite.

## Eutelus flavipes Walk.

Eutelus flavipes Walk. is one of the small chalcidid flies. The females have dark metallic-green bodies, cherry eyes, light brown legs, rather dark antennae, and are about 0.12 inch in length. The males are smaller, about 0.08 inch long, and have a broad yellow band across the abdomen. Their bodies are a lighter green and the legs and antennae are yellow. Each maggot supports a number of parasites, usually about a dozen. The pupae are formed in the body of the host in the outer resin mass. The adults emerge during the latter part of June. June 16, 1904, eight females emerged from one mass; June 18, 1904, four females and two males from one, and June 18, 1904, four females and nine males from another. The larvae are small, fusiform, segmented, footless, creamy-white grubs without any particular striking characters. Full-grown ones vary in length from 2½ - 4 mm. The large ones probably transform to females and the small ones to males. Eleven were found in one maggot skin on May 19, 1904.

## ASSOCIATES

Two small pill beetles (Amphicyrta simplicipes Mann. and Simplocaria nitida Mots.) were frequently found on and near the resin masses. Their relation, if any, to the maggot was not determined.

## CONCLUSIONS

(1) Western hemlock timber is often affected by a defect known as the black check, which renders a large percentage of the best wood worthless for finishing, turning, staves, and woodenware, the more valuable products, but apparently is not seriously detrimental to timber for other purposes.

(2) The black check is caused in nearly every case by an injury to the cambium (growing layer) of the trunk by the hemlock bark-maggot, Cheilosia alaskensis Hunter. Somewhat similar defects may be caused by barkbeetles, bark-borers, sapsuckers, or anything that makes a wound in the cambium, which afterwards heals.

(3) The maggot enters the bark through a small wound, usually one made by the hemlock barkbeetle (Hylesinus n.sp.) or sometimes by the sapsucker. It gradually enlarges the wound, in which it lives for several years, feeding on the sap. In the spring, when full grown, it pupates in the resin mass which has formed on the outer bark around the entrance to the wound. The pupa soon changes to the adult, which emerges in April or May. The egg is probably laid on the resin exuding from the small wound made by the barkbeetle or sapsucker.

(4) To prevent losses, use infected stuff for boxing or construction purposes, where it is not detrimental, and where clear stuff is required, select trees which are free from the black indicating spots (old resin masses) on the bark.

# THE FIR BARK-MAGGOT

## (Cheilosia hoodiana Bigot.)

## HISTORICAL

### First Record

The maggot and work of this species were discovered first at Satsop, Washington, on July 8, 1903, when the writer found a number of rat tailed maggots in resin masses in the bark of the trunk of a large lowland fir. Blackcheck was common in the wood beneath old resin masses.

### Investigations

In 1903. Investigations were started at the finding of the larvae on July 8th. Medium, large and prepupal stages were common in the bark of a number of trees. Medium and large larvae were also common on September 18th, October 12th, November 4th, and November 20th. Most of the larvae found in November were in the outer resin masses, hibernating. A number of large masses were caged on November 4th. On that date a number of scolytid barkbeetles (Hylesinus granulatus Lec. and Hylesinus n.sp.) were excavating short mines in the living bark. Their abandoned mines, filled with resin, were common in the bark, and from all indications were used as entrances by the maggots.

In 1904. At the earliest observations on May 7, most of the resin masses contained large larvae. Two pupa were found in the outer masses, however, and from all indications several adults had already emerged. The barkbeetles were excavating short mines and their old work was common. On May 8th one male emerged from a caged mass; on May 12th one female; May 13th one female, and May 16th one female. One pupa was found on June 9th. A number of large larvae caged on November 4, 1903 were in the same condition on June 14th. June 16th and June 18th two specimens, both females of Syrphoctonus maculifrons Say, an ichneumonid parasite, were

reared from caged maggots. On August 13th an adult male fly emerged from a resin mass caged November 4, 1905. Maggots at various sizes were common on August 20th and October 13th. They undoubtedly entered old barkbeetle wounds and probably other small wounds from which the resin was flowing. A medium sized maggot was found in a resin mass surrounding an old limb on the trunk of an Alpine fir at Smith's Ferry, Boise Co., Idaho, on October 24th.

In 1905. Satsop was not visited in 1905. On July 28, at Des Moines, Washington, a number of black checks were found in the wood of a large tree. On September 2nd a number of trees on the southern slope of Mt. Rainier, Washington, at an elevation of 4000 feet were examined. Resin masses containing medium to large larvae were common in the bark of the trunks. Old barkbeetle mines were also plentiful and the larvae evidently entered through them.

In 1906. The investigations of 1906 were made in the region directly west of the Yosemite National Park, California. On June 1st small, large, or prepupal larvae, and pupae were found in resin masses on the trunks of white firs at the Mariposa Big Tree Grove, 6000-7000 feet elevation. Some masses indicated that the adults had already emerged. On June 9th medium to large larvae and pupae were found at Wawona, 4000 feet. Some of the pupa were dark and appeared to be parasitized. Some adults had amerged. Most of the larvae appeared to enter the bark through axe or scrape wounds. No barkbeetle entrances were seen. June 14th small larvae and pupae were common at Summerdale, 4000 feet. Some adults had emerged. The wounds from which the pupae were taken were partially healed. On June 16th one female emerged; June 17th one male; June 18th, two females; June 19th, one female; June 20th, one male and four females; June 21st, one male and one female; June 22nd, one female; June 24th, one female, and June 29th, one male. The Star mine, 7000 feet, near Summerdale was visited on June 28th. Medium and large larvae were in the resin masses and many adults had emerged. The main brood seemed to be about two weeks later than at Summerdale. Small and rather large larvae were found at Summerdale on August 21st. At the last observation on September 5th, these same stages were common. The small larvae were evidently those of the 1906 brood, while the large ones were those of the 1905 brood. Wounds from which the adults emerged in 1906 were filled with new growth. No barkbeetles were found nor

could their work be seen, but the work of a small lepidopterous larva was common in the bark. It often caused a slight flow of resin and the maggot may enter through this.

Some dark, large larvae were collected from the outer resin masses on June 9, 14, 16, and 28. Five Syrphoctonus adults and a number of Mutelus emerged from these sometime in July or the first of August.

In 1907. The investigations of 1907 were confined to the western part of the Uinta mountains near Kamas, Utah. On June 10th, medium and large larvae were found in resin masses on the branches of healthy Alpine fir trees. The medium larvae and most of the large ones were in the inner round, but some large ones were in the outer mass, probably ready to pupate. There was no evidence of attack on the trunks of these trees, but the trunk of a dying tree nearby was infested with a pupa. The horns of this extended out from the mass and its tail was buried within. A male emerged about July 1st. On June 20th a large larva and a dark pupa were found in the outer resin masses on the trunk of a tree. A male emerged from the puparium about July 1st. On August 8th medium to large larvae were found in the wounds on large limbs of healthy trees. These larvae were actively feeding. No barkbeetles were found in the healthy bark and the cause of the primary wounds, if there are any in this case, was not determined.

## DISTRIBUTION

The fir maggot is widely distributed over the western and southern Rocky Mountain region and the Pacific Slope. The writer has collected specimens from Satsop, Des Moines, and Mt. Rainier, Washington; Smith's Ferry, Boise Co., Idaho; Mariposa Big Tree Grove, Wawona, and Summerdale, California; and Kamas, Summit Co., Utah. The fly has been reported from Mount Hood, Oregon (Bigot, 1884, Williston, 1886); New Mexico, (Cockerell, 1902); and Similkameen, British Columbia, (Osburn, 1908). It is found from the sea level to elevations of 7000 feet or more.

## FOOD PLANTS

As its name indicates, the fir maggot infests various species of true firs (Abies). The writer has reared it from the white, grand or lowland fir (Abies grandis Lindl.), the California white fir (Abies concolor (Gord.) Parry), and the Alpine fir (Abies lasiocarpa (Hook) Nutt.). Similar work has been seen in the red or magnificent fir (Abies magnifica Murr.), and possibly in the lovely fir (Abies amabilis (Loud.) Forb.) and the noble fir (Abies nobilis Lindl.) It probably infests all of the western firs.

## DESCRIPTION

### The Injury

The Primary Wound. The primary wound of this species varied with the different trees attacked. In the lowland fir it was similar to that in the hemlock, being made by the same and a similar species of barkbeetles (Hylesinus n.sp. and Hylesinus granulatus Lec.). In the California white fir no definite primary wounds were found. A small lepidopterous larva was mining between the inner and outer bark and it may cause the slight flow of resin necessary for the entrance of the maggot. The attack on the Alpine fir was similar to that of the white fir. No barkbeetles or any evidence of primary wounds were noticed.

The Finished Wound. The finished wound resembles that of the hemlock maggot very closely. The fir seems to be a faster growing tree than the hemlock, and the wound is apt to be deeper.

The Black Check. No special difference could be found between the check of the hemlock and of the fir. It may be a little larger and deeper, because of the more rapid growth of the fir.

## The Insect

The Egg. The egg was not observed.

The Larva or Maggot. The larva resembles the hemlock maggot. The shoulder tufts of bristles on the dorso-lateral surface of the thoracic and first abdominal segments are more pronounced. The dorsal warts of the first abdominal and the abdominal feet are longer and seem better developed.

Puparium and Pupa. The puparium and pupa could not be distinguished from the hemlock species.

The Adult or Fly. The adult of the fir bark-maggot is about the same size as the hemlock fly, but differs in color. The Washington specimens have the thorax dark brown and the abdomen a light brown or with bands of light and dark brown; the California specimens are a uniform dark brown; while those from Utah are almost as blue black as the hemlock fly. The California specimens are also slightly smaller in size. The males vary in the same way, being darker and having longer and more abundant hairs, smaller and darker antennae and their eyes are joined on top of the head. The body length is 9mm., the wing length 7.8 mm.

## SEASONAL HISTORY

The seasonal history of the fir maggot resembles that of the hemlock species very closely. Hibernating small and large larvae were found in the outer resin masses at Satsop, Washington (100 feet) on November 4 and November 20, 1904. They were not observed in California (4000 feet) and Utah (7000 feet). Overwintering large larvae were active at Satsop from May 7th to July 8th; at Summerdale, California, from June 1 to June 28; and at Kamas, Utah, from June 10 to June 20. Pupae were found at Satsop on May 7 and June 9; at Summerdale from June 9 to June 18; and at Kamas on June 10 and June 20. Adults emerged at Satsop from May 7 to May 16[1]; at Summerdale from June 9 to June 29; and at Kamas

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1 One belated male emerged August 12.

some time during the first half of July. Oviposition was not observed. Small larvae were found at Summerdale on August 21 and September 5. They were actively feeding. Overwintered medium-sized larvae were actively feeding at Satsop from May to November and at Summerdale and Kamas from June to October. All of the evidence tends to show that the species lives as a maggot in the resin mass for two or more years.

## HABITS

Larval. The larvae vary in habit with the host tree they infest. In the lowland fir in Washington and the white fir in California they are similar to the hemlock species, but in the Alpine fir in Utah the most of them are found in wounds on the limbs. A few, however, attack the trunks.

Adult. Though diligently sought for, no adults were collected in the field, so they must be very retiring in habit.

## ECONOMIC FEATURES

In general, the injurious character of the work of the fir maggot is the same as that of the hemlock maggot. The damage, however, is less because the fir has not yet become of much economic importance. When it does, which is only a question of time, it will probably be used as pulp wood, and the black check will then cause a great deal of trouble and expense, except in localities where it injures the limbs instead of the trunk. The methods of preventing losses from the hemlock maggot should be used against the fir species.

## NATURAL ENEMIES

The fir maggot is attacked by the same natural enemies as the hemlock maggot.

Syrphoctonus maculifrons Cr. Two females of this species were reared from resin masses on the lowland fir at Satsop, Washington. One emerged June 16, 1904, and the other June 18, 1904. Five adults were reared from masses on the California white fir. All of these emerged some time in July, 1906. One male and one female were obtained from masses collected at Lawona on June 9, one female from a mass collected at Summerdale on June 14, and one male and one female from masses collected at Summerdale on June 16.

Eutelus flavipes Walk. Two maggots parsitized by Eutelus were collected from masses on the california white fir. From one collected at Summerdale on June 16, 1906, one male and five female parasites emerged some time in July. From the other collected at the Star Mine, near Summerdale on June 28, 1906, two males and fourteen females emerged about August 15, 1906.

All of the parasitized maggots were dark colored and could easily be separated from the healthy ones.

## ASSOCIATES

One adult of the pill beetle, Amphicyrta simplicipes Mann., was found near a resin mass on the trunk of a fir, at Satsop, Washington, on November 4, 1905.

## CONCLUSIONS

(1) The maggot of Cheilosia hoodiana Bigot, a near relative of the hemlock maggot, attacks the bark of healthy trees of lowland fir (Abies grandis Lindl.), California white fir (Abies concolor (Gord,) Parry), Alpine fir (Abies Lasiocarpa (Gord.) Nutt.) and probably other species of firs, in the Rocky Mountain and Pacific forests, and causes a similar black check to form in the timber.

(2) The loss caused by this check is not now very great, because the fir is not yet used to any great extent, but it will be in the near future when the fir comes into

use for pulp wood, etc.

(3) The methods of preventing losses caused by the hemlock maggot should prove equally effective with the fir maggot.

# THE SPRUCE BARK-MAGGOT

(Cheilosia sp.)

## HISTORICAL

This bark-maggot was the first species found by the writer. It was observed first on June 8, 1903, in the resin exuding from a large wound on the trunk of a tideland spruce (Picea sitchensis (Bong.) Trautv. & Mayer), at Hoquiam, Washington.

## Investigations

In 1903. Medium and large larvae were collected at Hoquiam on June 8. They were working in the soft resin at the edge of a large wound and seemed to be keeping it open. Medium larvae were found under the same conditions on August 27, and large ones on September 1 and October 13. The wounds, though of various kinds, were usually large, were distinguished by an excessive flow of resin, and often contained the larvae of the spruce pitch-worm (Parharmonia piceae Dyar).

In 1904. The observations of 1904 added little to those of 1903. Medium larvae were found on May 4, medium and large larvae on May 20, and small medium, and large larvae on July 11. In every case the maggot was associated with the pitch worm. Some empty puparia were found in the dry resin of an infested wound and may belong to this species.

## DISTRIBUTION

Hoquiam, Washington, was the only locality in which the spruce bark-maggot was observed, but there is no reason why it should not be found throughout the range of its host, the tideland spruce, which inhabits the coast from

northern California to Alaska.

## FOOD PLANT

The only plant found to be attacked by the tideland or Sitka Spruce (Picea sitchensis (Bong.) Trautv. & Mayer.) Many insects which attack this tree also attack the Engelmann spruce (Picea engelmanni Engelm.) and this maggot may be one of them.

## DESCRIPTION

### The Injury

The maggots enter any wound which causes a flow of resin. They were found in scrapes, axe wounds, and those made by the pitch worm. They work around the edges and by abrading the surface of the new growth prevent healing. Generation after generation comes in and a serious injury is formed. Dark resin is deposited in the surrounding tissues, and if the wound finally heals an ugly check remains in the timber. Often, however, other insects or fungi enter and a large decayed spot is formed. This may become so extensive that the tree breaks off and falls, a complete loss.

### The Insect

The larva or maggot was the only stage of this species In general appearance it resembles the maggots of the preceeding species of Cheilosia and undoubtedly belongs to that genus. The body is stouter and the tail is much shorter in porportion, the mouth hooks are not so well developed, and the small feet of the tail seem to be missing. The ventral and dorsal pairs of tail feet are much larger and each fork of the terminal piece bears four tufts of three to four plumose bristles each instead of four bristles. The body of a full grown larva is 9 mm. long, the tail 3 mm. long.

## SEASONAL HISTORY

The spruce maggot is evidently very similar to the other species in seasonal history. It passes at least two winters in the larval stage. Medium (year old) and large (two-year old) larvae were found throughout the period of observation May 4 to October 13; small larvae on July 11.

## HABITS

The larvae live in the soft resin at the edges of the wounds. They move back and forth and do not seem to mind being covered by the exuding pitch. The tip of the tail, however, shows from its formation that it usually floats on the surface so that air may always be obtained. Pupation probably takes place in the dried resin. Some puparia that may belong to this species were found in several wounds. A number of larvae may live in a single wounds, but each seems to keep by itself. Several generations may inhabit the same wound and so keep up the irritation year after year.

## ECONOMIC IMPORTANCE

So far as could be determined the spruce maggot under natural conditions does no great amount of damage. But where man has come into the forest, followed by fires and lumbering and the resulting wounds in the remaining standing timber, it causes some injurious defects and often indirectly, through fires, fungi and other insects, the loss of many trees.

## METHODS OF PREVENTING LOSSES

The methods of preventing losses in this species is practically the same as with the others. Mature timber

should be selected and used for the purpose for which it is best suited. Growing timber should be well cared for and carefully lumbered. Few wounds are necessary in a properly treated forest, and these should be carefully trimmed and covered with some cheap repellant, as tar or crude petroleum, to keep the maggots and other enemies out.

## ENEMIES AND ASSOCIATES

No enemies were observed. One specimen of an unidentified dipterous larva, possibly an Oscinid, was collected from a maggot infested resin wound. This is 7 mm. long, rather cylindrical, lanceolate, with a small retracted head tapering down to a large caudal segment. The first segment back of the head bears a pair of ear-like two branched spiracles and the caudal surface of the last segment bears a pair of cylindrical projecting spiracles. Excluding the head, there are eleven well-defined segments. The body is covered with a number of fleshy tubercles but is seemingly without spines. This species may be either a parasite or an associate. The spruce pitch worm (Parhormonia piceae Dyar) is nearly always an associate. It often makes the primary wound for the entrance of the maggot.

## CONCLUSIONS

(1) Tideland spruce in Washington is sometimes injured by a maggot (Chèilosia sp.) which lives in resinous wounds on the trunk. These wounds cause a check to form in the timber or afford an easy entrance for fungi and other timber destroyers.

(2) Trees injured in lumbering or other operations furnish the best conditions for attack and are often seriously damaged.

(3) To prevent losses in mature timber the injured stuff should be used to the best advantage; in growing timber, the lumbering and other necessary operations should be carefully carried on to prevent wounds. Such as are una-

voidably made should be carefully treated with tar or petroleum to keep out the maggots and other destroyers.

# THE PINE BARK-MAGGOT

## (Chyliza sp.)

## HISTORICAL

The pine bark-maggot was noticed first at Moscow Mt., Idaho, on September 29-30, 1903. Puparia were collected from the dried resin which was exuding from axe and scrape wounds in the trunks of small yellow pine (Pinus ponderosa Laws.) trees. On October 26, 1904, at Smith's Ferry, Boise Co., Idaho, a small yellow pine was found which had been attacked in a number of places on the trunk by a sapsucker. Puparia were quite common in the resin of these wounds. One was also found in a dry resin mass which had oozed out of the bark of a lodgepole pine (Pinus murrayana Oreg.Com.). The first larvae were found at Summerdale, California, on September 10, 1906. These seemed to be full grown. They were common in sapsucker, nail, and other small wounds in the trunks of the lodgepole pine. Usually there was only one larva in a wound, but sometimes there were several. An adult female emerged from a puparium in the laboratory at Washington, D. C., on April 11, 1907. Its wings failed to develop, and Mr. Coquillett could only identify it as a species of Chyliza, family Psilidae.

## DISTRIBUTION

The pine-maggot was collected at Moscow Mt., Latah Co., and Smith's Ferry, Boise Co., Idaho, and Summerdale, Mariposa Co., California. It probably occurs in the Rocky Mountain and Pacific states throughout the range of the yellow pine and lodgepole pine.

## FOOD PLANTS

The yellow pine (Pinus ponderosa Laws.) and the lodgepole pine (Pinus murrayana Oreg.Com.) were the only trees

found to be attacked by this species.

## DESCRIPTION

### The Injury

The primary wound is usually an irregular one from which fresh resin is exuding. It is caused by a scrape, axe, nail, sapsucker or barkbeetle (Dendroctonus). The maggot enters through the resin and enlarges the wound until it is finally from one to two inches in diameter and very irregular, thus differing a good deal from the regular circular wounds made by the hemlock bark-maggot and the fir bark-maggot. The maggot finally becomes fully developed and leaves the wound which heals over with new growth and becomes a dark check in the timber.

### The Insect

The Egg. The egg was not observed.

The Larva or Maggot. The full grown larva is a gradually tapering, lanceolot creamy white, 13 segmented, maggot, 12 - 14 mm. long. The anterior or head part is smallest, 1 mm. in diameter, and the posterior or tail part largest, 2 mm. in diameter.

The smallest segment forms the head. The dorsal part is composed of a fleshy bilobed antennal piece each lobe of which bears two tubercles or joints. Below this is a pair of fleshy flaps and slightly below them is a pair of small simple hooks which protrude from the fleshy mouth.

The second segment (Ist thoracic) bears on each posterior dorso-lateral surface a fan-shaped ear-like spiracle bearer. Each fan is divided into from 8 - 11 small cylindrical branches.

On the anterior dorsal surface of the 3rd to 10th (2nd and 3rd thoracic, 1-6 abdominal) segments there is a fleshy roll which is covered with a number of short, stout, brow-

nish spines. Similar rolls are on the anterior ventral surfaces of the 4th to 12th (3rd thoracic, 1-8th abdominal) segments. These dorsal and ventral rolls are connected by lateral ones on the 4th to 9th (3rd thoracic and 1-5th abdominal) segments and thus form rings around the body. The dorsal and ventral rolls are large and broad, but the lateral ones are small and narrow. The 3rd (2nd thoracic) segment also bears a pair of the lateral rolls.

Near the posterior ventral surface of the 8th-11th (1-7th abdominal) segments is a smooth fleshy roll. This seems to develop into a pair of fleshy feet on the 12th (8th abdominal) just in front of the vent.

The dorsal surfaces of the 12th and 13th (8th and 9th abdominal) are not separated. This united surface contains a well defined median and two lateral canals or depressions and bears on its lateral and posterior margins six large fleshy spines.

The caudal surface of the last or 13th( 9th abdominal) bears a heavy dark chitinous dorso-median plate and two lateral fleshy spines. The plate extends into two stout dorsally curved hooks.

The Puparium. The puparium is formed from the last larval skin which thickens into a blackish barrel-shaped covering, 7-9 mm. long, and 2-3 mm. in diameter. The caudal plate with its two stout hooks marks the posterior end and the pair of fan-shaped ear-like spiracle bearers projecting from the anterior dorso-lateral surfaces indicates the anterior end. The spiny larval folds and the separations of the segments give the whole a faint ringed appearance.

The Adult or Fly. Only one adult, an imperfect female, was reared. This is rather a slender fly about 7 mm. long. It has a black body covered with a grayish pubescence and yellowish or tawny legs. The eyes are large and widely separated. The antennae are three-jointed. The first joint is small and almost buried in the head, the second is rather large and subconical, and the third is about the same width as the 2nd but longer, rather rectangular, and slightly rounded at the distal end. It bears a long smooth bristle on its outer proximal surface. The general color is a yel-

vety black with tawny inner margins. The wings failed to expand.

## SEASONAL HISTORY

The pine bark-maggot passes the winter as a pupa in the dried resin of the wound, pupation taking place some time in September. Large larvae were found on September 10, 1906, but at the other observations on September 29-30, 1903, and October 26, 1904, nothing but pupae were found. The adults emerge in the spring, probably June. The only one reared emerged on April 11, 1907. But this passed the winter in a warm laboratory and probably came out several months before its proper time. The eggs are laid in June or July and the larvae become full grown by September. The life cycle is thus about one year, adults emerging in June from eggs laid the preceeding June or July. The length of the different stages would be, larva about three months (June 15, July, August, September 15) pupa about nine months (September 15 October, November, December, January, February, March, April, May, June 15) and adult one month June 15, July 15).

## HABITS

The maggot lives in the wound working on the healing tissue around the edges. It is completely buried under the resin and moves about at will, thus differing from the fir and hemlock maggots, which always have to have their tail spiracles out on the surface of the resin mass for air. It keeps the wound open by tearing the tissues with its hooks. When it becomes full-grown it forms a cell in the mass of hardening resin and pupates. The pupa changes to an adult which pushes the anterior end of the puparium aside and emerges. Sometimes several larvae work in the same wound.

## ECONOMIC FEATURES

No observations could be made on the actual economic importance of this insect. It was fairly common where studied and must cause a great deal of checky timber. But its host plants are not used where fine grades of timber are required and the defects it causes probably do not seriously damage the timber for rough uses.

Infested trees can easily be told by the masses of yellowish resin exuding from the wounds in the bark. These masses are larger and thicker than ones exuding from simple wounds and do not form tubes like the masses thrown out by the barkbeetles.

Wounds caused by lumbering or other operations afford the most favorable conditions for attack.

Losses should be easily prevented by carefully lumbering to prevent wounds or by treating the unavoidable wounds with tar or petroleum (skid grease).

## NATURAL ENEMIES AND ASSOCIATES

No natural enemies were found. An unidentified Lepidopterous larva (pitch-worm) often works in the same wound as the maggot.

## CONCLUSIONS

(1) Lodgepole pine and yellow pine in the Rocky Mountain and Pacific States are sometimes attacked by a fly (Chyliza sp.) maggot which lives in wounds in the bark of the trunk and causes a check to form in the timber.

(2) So far as could be determined, the check causes no serious damage because the timber is used only for rough stuff where the check is not injurious.

(3) The trouble should be easily controlled by careful lumbering, to prevent wounds and by treating wounds unavoidably made with tar or petroleum.

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A short account of some of the habits and the work of the maggot of an unknown fly which causes a defect known as the black check in the wood of the western hemlock.

Defect in the wood figured. First record of the work.

1905, Burke, H. E. - Black Check in Western Hemlock. Cir. No. 61, Bur. Ent., U. S. Dept. Agric., pp. 1-10; Figs. 1-5

Notes on the economic importance, work, damage, distribution, life history, parasites and closely related species of Cheilosia alaskensis Hunter, and remedies suggested for the black check which it produces in western hemlock. First record of C. hoodiana Bigot and other unknown species which produce black check in timber.

## APPENDIX

### Original Descriptions

1884, Bigot, J. N. F., Ann. Soc. Ent. Fr., ser. 6, tom. II, pp. 552-553.

Cartosyrphus hoodianus, ♂ Length 9 mm.

"Black, scattered dark and ashy hairs. Antennae reddish yellow, arista dark, with short hairs; face black, shiny, dark hairs on both sides, front black, with rough hairs; alulae nearly white; halters with chestnut tips; abdomen black, opaque; gray hairs on both sides, segments 1, 4, and 5 shiny, 2 and 3 on both sides at base strongly shiny; feet black, knees of the tibiae reddish yellow at the base; wings pale gray with a dark spot and stigma at the base. (In Latin).

Antennae tawny, arista brown, medium hairy; face shiny black with some brown hairs on the side; front with black hairs; eyes hairy; thorax shiny black, with sparse brown hairs; alulae whitish; halters with a brown club; abdomen dead black, furnished with some long gray hairs on the sides, 1, 4, 5 segments shiny, 2-3 with a triangular shiny spot on each side; feet black, with some scattering gray hairs; knees, strictly the base of the tibiae, tawny; wings of a very clear gray; darker toward the external margin; base and stigmatic spot of a pale red. North America (Mount Hood), 1 specimen (In French).

1897, Hunter, W. D., Can. Ent., Vol. XXIX, p. 124, pl. V, fig. 4, June.

Cheilosia alaskensis n. sp. Every where deep blue, shining very short pilose. Eyes pilose, arista scarcely pubescent, incrassate on the basal half, scuttellum with bristle-like hairs.

Female: Eyes very short sparse pilose, appearing white from above. Front shining blue, sparsely punctured short black pilose, with a large sulcate swollen area above the antennae. Face very prominent, deeply concave below the antennae to the rounded, very prominent tubercle

situated a trifle below the middle of the eyes, thence shortly but not very deeply concave to the epistomal tubercle which is only slightly less prominent than the upper, and is situated considerably above the lower eye margin. Below the lower tubercle straight, slightly receding. Cheeks narrow, lower border straight, epistoma not truncated at tip. Antennae and margin of the antennal orifice reddish-yellow, first and second joints and the narrow upper margin of the third brownish. Third joint very large, circular with the upper outer margin slightly less convex. Arista long, basal, brown, very indistinctly pubescent. Thorax shining blackish-blue, short black pilose. Scutellum with slender bristles on the margin. Abdomen oval, wider than the thorax, everywhere shining dark blue, almost bare. On the dorsum of the abdomen the pile is black, on the margins especially anteriorly, it is white, and on the sides of the second segment rather long. Legs black, knees and narrow base of the tibiae only lighter, short black pilose. Wings hyaline, the stigma and all the veins light luteous. L. corp. 8 mm., L. al. 8 mm.

One specimen, Cook's Inlet, Alaska; Prof. L. L. Dyche, of the University of Kansas.